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MARKETING INFORMATION SYSTEMS: AN EMERGING VIEW

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MANAGEMENT INFORMATION SYSTEMS: AN EMERGING VIEW

by David B. Montgomery and Glen L. Urban

Recent years have witnessed an increasing interest in marketing information systems. It is currently fashionable for companies to have such systems under development and the professional and popular management literature abound with articles describing system developments. In the main, these systems have tended to emphasize the data collection, storage, retrieval, and display functions of a marketing information system. Yet, if the full potential of the new information technology is to be harnessed for management use, it seems imperative to take a broader view of information systems. Information systems can be designed to assist managers directly in planning and decision making by combining management science, statistics, computer science, and market data into an integrated decision-information system.

The principal purposes of the present paper are:

1. To present a conceptual model for the evolutionary development of integrated marketing information systems,

2. To illustrate the need for a planned, co-ordinated growth of all components in the system,

3. To present design concepts relevant to the development of the components of the system, and

4. To identify new developments which will spur the evolution of marketing information systems and broaden the base of companies which may have access to the new technology.

To accomplish these purposes a conceptual model of a marketing information system will be presented. Then the components of this system will be discussed in detail.

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A CONCEPTUAL MODEL OF A MARKETING INFORMATION SYSTEM

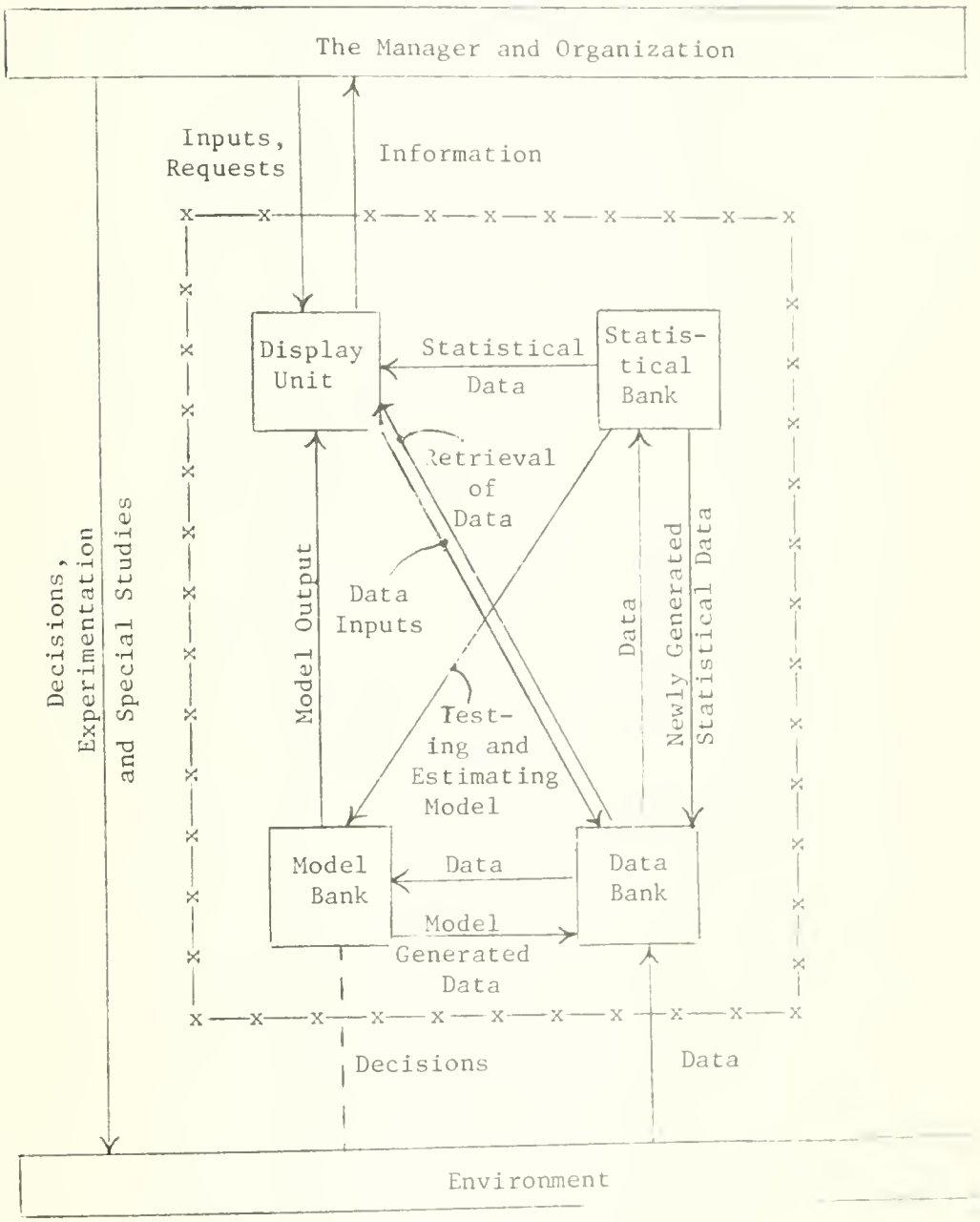
A marketing information system is composed of four major internal components: (1) a data bank, (2) a measurement-statistics bank, (3) a model bank, (4) a communications capability. These interanl components interact with two external elements: (1) the manager or user, and (2) the environment. The environment includes all the conditions, activities, and influences affecting the marketing activities of the firm. A diagrammatic representation of these components and their interactions is presented in Figure 1.

The System Compontents

The data bank provides the capacity to store and selectively retrieve data which result from monitoring the external environment and from internal corporate records. The manager will probably not be interested in the raw data per se. For decision purposes he will generally require the data to be processed in some manner. In the simplest case, he may require sales summaries or market share information, which involve further processing of the raw data. Thus the data bank must also provide the capacity to manipulate and transform data, as well as, store and retrieve it.

The data from the data bank may be displayed directly to the manager, but in many cases it will be analyzed by statistical methods. The measurement-statistics bank provides the system with the capacity for more complex analysis of data such as multiple regression cluster analysis, factor analysis, and multi-dimensional scaling. In addition to providing the ability to statistically analyze data from the data bank, the measurement statistics bank should also contain procedures for obtaining and evaluating subjective marketing judgment. For example, these judgmental measurements

Figure 1: Information System Structure



*Adapted from Montgomery and Urban [23]

may be in the form of sales forecasts, forecasts of competitive promotion or subjective utility assessments. Judgmental measurements have been and are likely to continue to be important inputs to marketing models. The judgmental data may be stored in the data bank for later use.

The model bank provides a variety of marketing models at different levels of complexity appropriate to the understanding and solution of marketing problems. Examples would be budgeting models, new product planning models, and media selection models. The models make use of the data from the data and measurement-statistics banks, as well as, direct user input and subjective measurements. The model bank interacts with the statistical component since the adequacy of a model may be assessed using the methods available in the measurement-statistics bank. In special cases models may interact with the environment. This occurs when models are delegated authority to make routine decisions directly as in the case of certain inventory reorder systems and Amstutz' stock market model.[1]

The final system component is the communications capability. It provides for a two way link between the user and the system. It is a critical element since meaningful communication is necessary if the system is to be used.

The Data Bank-Model Bank Interaction

The brief sketches given above indicate some of the interdependencies between the system components. Perhaps the most crucial interdependency relates to that between the models which go into the model bank and the data which are retained in the data bank. Marketing models generally require data for use in model formulation, in choosing among alternative market

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[1] See [3].

response relationships, and in model testing and validation. Market data relevant to the dynamics of the market place are generated over time, often with considerable time lapses between observations. Thus at any point in time, the development of a marketing model is constrained by the data (perhaps judgmental) which are available. If important pieces of information are missing, model development will have to rely heavily on judgment until the appropriate data develop over time. While this is not meant to demean the role of judgment and sensitivity analysis of judgmental inputs to models, managements' faith in models and their willingness to use them does seem positively related to the exposure of the model to actual market data. Consequently, decisions made today as to what data to obtain and to retain in the data bank have long run implications for future model development.

Two recent examples from the experience of one of the authors will illustrate the point. The first example relates to a firm which is in the process of forming a multi-firm marketing information system in the pharmaceutical industry. One of the key elements in this new system is the development of models to assess the impact of competitive market communications. In this industry, market communications take three forms: journal advertising, direct mail to doctors, details (sales calls) on doctors. Commercial data sources have existed for some time on each of these activities. Past usage of the data has, however, tended to be for short run assessment of the market. As a result, old data have been discarded. Data are available only back to 1967, which seriously limits the data base on which the dynamic measurement models may be formulated and tested. Now that models are being developed which require this data, more complete data

retention in the future seems assured. The second example relates to a research study on a non U.S. market being done in conjunction with the international division of a large drug firm. In this international market, as well, much potentially valuable data (such as competitive detailing) has been discarded by the commercial supplier of the data. Thus again, valuable raw material for model development has been lost because it was viewed as "current information" by the supplier, who gave no thought to the possibility of future model development.

The above are not at all isolated examples. It is painful to contemplate the volume of potentially useful data which has been discarded both by companies and commercial suppliers. The remedy seems clear. If a firm expects to become active in marketing models at any time in the next five years, it is imperative that it now assess something of the likely form of these models and their requirements for data. Hopefully, the discussion of the model bank in a later section will provide some assistance in making this assessment. This assessment should then have an impact on decisions to obtain and retain data.

Further examples can be given of the interdependency between models and data. Models provide a framework for identifying what data should be collected and how it should be processed once obtained. In a recent paper Madansky[2] states "... that modeling has produced and will produce both the impetus within companies for an organized, unified, coherent data collection program and the spark for novel types of data to be collected." He goes on to cite an example in which one of their clients, a multiproduct, multisales-area company, wanted a computer based system to organize the vast volume of

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[2] See [22].

data it collected and purchased. The goal was to obtain useful information for advertising and sales promotion decisions. The first step was the structuring of a decision model based on variables for which data was already available or readily obtainable. The model identified additional data needs. In addition, the model also prescribed the form of the data required for analysis. Thus it specified the manipulations and transformations which were required to provide the data in model-compatible form. In this case the transformation suggested a revision in the data collection procedure to make the data directly compatible with the model. In Madansky's words, "... we have gone from a decision model to a data bank organization scheme for the client."[3] The Little-Lodish media selection model, MEDIAC, provides another example.[4] Their model utilizes only single media exposures and paired duplications of exposures in developing a media schedule. Hence, the model again specifies the data collection scheme -- no triplication data, no quadruplication data, etc. are needed to select media.

Integrated System Implications for Organization of System Development

These interdependencies between systems components, particularly the intimate relation between models and data, have significant implications for the composition of a team assigned the task of developing a marketing information system. Consider for the moment the corporate groups generally responsible for the various activities which are subsummed in the information system. Traditionally, market research has been concerned with the types of data collected and with programs and methods for its analysis (the measurement-statistics bank). The computer system group generally has responsibility for

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[3] See [22].

[4] See [16].

for maintaining computer based data files and generating management reports (one aspect of the communications function). Finally, models usually fall in the perview of the operations research staff.

When the marketing information system is viewed as a data storage and retrieval system with some associated report generation and statistical analysis, the system development team will most likely be composed of representatives from marketing research and computer systems. This, in turn, is likely to lead to data and system design decisions which will not serve the future model development needs of the firm. What is needed is a system development team composed of representatives from all three functions in order to assure the best opportunity for balanced system development. Perhaps the ideal organization structure would be a staff group called something like marketing information services. This group would have responsibility for the total system including marketing-operations research. It would have its own computer programming capability as well as access to computer hardware both internal and external to the firm. This latter point seems important in view of the frequent complaints from marketing personnel that they can not get service from the corporate computer staff. Since most corporate computer staffs grew out of accounting type applications, large scale, routine data processing of billings, payrolls, and orders generally take precedence over other applications. Either these staffs must be trained in the marketing concept or marketing will have to access outside time sharing computer utilities and computers with remote batch processing capabilities.

DETAILED CONSIDERATION OF SYSTEM COMPONENTS

With the understanding of a conceptual model of an integrated information

system made up of a data bank, measurements statistics bank, model bank and communication capability, these components now will be analyzed in depth and emerging trends in their design will be indicated.

The Data Bank

The data bank involves two primary aspects: (1) the data, and (2) computer based and manual systems for data storage, retrieval, manipulation, and transformation. In the discussion of these two aspects, several emerging design concepts will be outlined.

The data

While as extensive discussion of appropriate data for the data bank is outside the scope of this paper, it should be noted that careful consideration must be given to the specification of what data will be maintained within the system. The specification must give forethought to future activities in marketing models for the reasons cited in the previous section.

Some examples of data categories which might be maintained in the data bank of a consumer goods company are:

I. Internal Corporate Records
   - A. Financial and Cost Data by Product and Time Period
   - B. Internal Report Data
     1. Saleman's call reports
     2. Marketing mix data by product, by time period, by market
     3. Sales performance information on previously implemented new products
     4. Life cycle information on products in the line
     5. Copy and format data on company advertisements

C. Judgmental Inputs

1. Judgmental forecasts by product, by time, by forecaster
2. Estimates of market sensitivity to company and competitive marketing activities

II. External Data

A. Secondary Sources

1. Government data (e.g. population demographic data by ZIP coded area)
2. Commercial data (e.g. M.R.C.A. panel data, Nielsen store audits, B.R.I. data)

B. Primary Data

1. Test market information
2. Market experiments
3. Market structure analysis
4. Competitive marketing activity
5. Advertising performance measures (e.g. Schwerin, Gallop-Robinson, Starch)

While the above outline is far from exhaustive, it does illustrate some of the basic types of market data which might be maintained within the system. The collection and maintenance of competitive market activity data will be increasingly important as better models are developed to assess the impact of competitive activities. The collection of these data will, of course, support the development of better models. Many of the data categories will subsequently be related to each other in order to gain understanding of market response. For example, the data file on copy and format in company advertisements (I.B. 5) may be related to advertising performance measures

(II.B.5) in order to learn systematically how the market is responding to these characteristics of ads. Cox and Good[5] report that one large consumer goods company is doing precisely that, while Diamond[6] has developed an on-line model called ADFORS which utilizes the results of such analysis.

A key concept in the design of a data bank is to maintain data in disaggregated form -- i.e. maintain data in its most elemental form. In the case of salesmen's call reports, disaggregated data might be the details of a sales call such as person visited, time of visit, place of visit, sales aids used, etc. An aggregated form for such data might be simply the number of sales calls made by a salesman to accounts of a given type over some time period. The purpose of maintaining disaggregated data is to enhance the flexibility of its future use. If data are maintained only in aggregate form, the possibility of organizing them differently for future, but at present unknown, purposes is sacrificed. An excellent example of the benefits of this future flexibility is given by Amstutz[7] in discussing his computerized portfolio selection system. He states, "If initial data files had been structured to maintain information at the level of aggregation required when the system was begun, many operations of the present system would be precluded by data limitations."

Since the cost of physically storing disaggregated data is high, initially the data may not be maintained in computer disk storage. Rather it might be stored on tapes or cards, or even original work sheets. It is important, however, that is be preserved so that it can be accessed by model builders and managers when it may be required.

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[5] See [4].

[6] See [5].

[7] See [3].

The data bank should maintain information regarding who used which data and for what purposes. This should provide information upon which to base decisions regarding which data should be kept in high speed computer storage. Thus the data bank should gather information appropriate to adapting itself to better meet the needs of its users and developing specifications for the storage of disaggregated data.

Systems for Processing the Data

The processing systems in the data bank should be able to perform the following basic operations:

1. Data Pre-processing. This involves the ability to clean and edit data.
2. File creation, reorganization, and deletion.
3. File maintenance and updating.
4. Information retrieval.
5. Logical operations on data. This operation will prove useful when a file is being prepared for statistical analysis.
6. Data transformation. The ability to perform arithmetic operations on data is crucial to simple analysis such as computation of market shares as well as to more complex statistical analysis.
7. Report generation. The system should be able to generate reports readily in nearly any desired format.

Two key issues in the development of the processing systems within the data bank are modularity and flexibility. Since the design of the data bank will be an evolving one rather than a one-shot, foreven optimal result, it is imperative that the system be readily adapted to change. Perfect foresight is not required if the system is flexible. Modularity in

the processing systems (i.e. compartmentalization of the processing functions) will tend to minimize the problems involved in adapting the processing systems to future requirements, since then existing moduals can be linked to meet the new demands.

Flexibility in the processing of data may be achieved by developing a variety of general commands which may be used to retrieve and manipulate the data. These general commands may then be called upon to operate on the data, whatever the data file may be. The development of these general commands, which are not specific to a particular data file, greatly reduces the problems which result when a file is altered by additions, deletions, or reorganization. An example of an operational data handling system using such general commands is the DATANAL system developed by Miller.[9]

Security Systems

The data bank must have security systems at both the processing systems level and the data level. At the systems level it is necessary to protect the system itself from the user; that is, prevent a user from inadvertently altering one of the system programs. Such user generated accidents can prove both costly and frustrating.

For the purpose of the present discussion, a more interesting aspect of the need for security systems is that of data security systems. The problem here is who may have access to what. It is clear that there must be bottom up security -- i.e. individuals below a certain level in the organization should not have access to certain types of information. But it should also be noted that there may be a need for top down security

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[9] See [21].

-- i.e. there may be data which should not be conveniently accessible to, say, the marketing vice president. A case in point is given by Amstutz[10] in which a sales vice president spent altogether too much of his time worrying about sales results in individual territories. In this case he was able to access very detailed information which distracted him from his real assignment - that of providing overall market planning and strategy.

In addition to vertical security, there is a need for horizontal security systems. As noted by Ackoff[11] organizational harmony and efficiency are not necessarily enhanced by letting, say, marketing and production have complete access to one another's data files. The notion of horizontal security between firms becomes important with the emergence of the multi-firm marketing information system.

Communication of data.

A data bank must be accessible to the manager. An interactive man/system operation is an important system design aspect, but it will be reserved for complete discussion in the section on the user-system interface. However, the capability a remote terminal provides a manager does allow the data bank to carry out one more function. This function is "data browsing." That is, the manager is able to look at will at various aspects of the company's operations data in an effort to find problems before they are severe enough to obtain management's attention through standard means such as exception reporting.

Although the ability to access data in a relevant form in important, it is not enough. Information systems must function to digest, analyze, and

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[10] See [2].

[11] See [1].

interpret data so the managers can improve decisions. There is a grave danger that if the data bank is over-emphasized relative to analysis and models, the manager will suffer a data overload and receive little help in decision making. This leads to the consideration of the model bank and the measurement-statistics bank which are designed to help the manager analyze and make sense out of data.

The Model Bank

The model bank provides the market information system with a capability to assist directly in decision making. The model bank should contain a multiplicity of models appropriate for different purposes such as understanding market behavior, diagnosis, control, prediction, and strategy formulation. The models incorporated in the model bank will be those which are likely to experience recurrent usage. Models for the analysis of one time market situations will remain, but these models will often by "back-of-the-envelope" models such as the interesting price timing model developed by Hess[12]. Unless these models have a potential for recurrent usage they will not be made a permanent part of the computerized model bank, although they may temporarily reside in the model.

Some Model Bank Design Aspects

The model bank should contain models of varying levels of detail within each class of models and for each marketing problem area. The various models would be useful since they would reflect alternate model cost/benefit tradeoffs. The best level of detail for a model ia a particular problem is not easy to determine. It is highly dependent upon the level of

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[12] See [13].

detail that is required to solve the problem. More detail is generally useful, but as more variables are included in the model, as more phenomena are considered, and as more disaggregation takes place, the time and financial costs of model development, input generation, operation, maintenance, and testing increase rapidly. The best level of detail in a particular application will depend upon the time and resource constraints on the model development and operation as compared to the improvement in the decision fostered by the higher level of detail.

The model bank concept represents a partial solution to this problem since if alternate models of varying levels of detail for a particular problem reside in the model bank, the decision maker will have the opportunity to select the level of detail he judges as best. For example, SPRINTER, a model for the analysis of frequently purchased consumer goods, exists in three levels. Mod I is a very simple description of the diffusion process.[13] Mod 2 adds the controllable variables of advertising and price to the model. Mod 3 uses a very detailed market response model based on the behavioral buying process and adds variables of sampling, coupons, margins, and sales calls.[14] Mod I is simple but runs at 10% of the cost of Mod III, and 50% of the costs of Mod II. With these alternatives the managers can select the model which has the best cost/benefit tradeoff for his particular problem.

The model bank might even contain a number of models at a given level of detail for a given problem with the understanding that each of the models is particularly meaningful to specific managers and their decision styles.

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[13] See [37].

[14] See [38].

Thus, the model bank may ultimately have several levels of model detail and multiple models at each level of detail in order to service the decision needs of the various marketing managers in the firm. This implies that the development of the model bank must be an evolutionary, adaptive process which adjusts to the varied and changing needs of the managers.

The models should be designed to be compatible with models at other levels of detail. In this way the simpler models could be used to evaluate a large number of alternatives and the more detailed models could be called upon to evaluate the specific outcomes of one or a few of the alternatives generated by using the less detailed model. For example, an aggregate advertising budget model might be used to specify an annual budget. Then a media allocation model could be used to indicate the best media schedule and finally this schedule could be submitted to a micro-analytic simulation to obtain detailed attitude change and micro purchase response results by market segment. The results of the simulation might indicate the need for adjustment of the preceding analysis of budget level and media schedule and will also provide a benchmark for control purposes once a policy has been implemented. This compatible usage of models in the model bank will allow the low cost combination of the capability for examining many alternatives with a high level of model detail. This compatibility should strengthen the value of the model bank and improve its ability to service decision makers.

Trends in Marketing Models

The model bank concept is being supported by a number of new developments in modeling.[15] The first is the emergence of a problem centered

[15]This section is designed to emphasize the directions of expansion of the state of the art, rather than the basic methodology of existing models. A detailed and complete discussion of basic models may be found in Montgomery and Urban [24].

orientation. Much of the early work in marketing models could be characterized as techniques looking for problems. This often resulted in a sacrifice of marketing relevance in order to achieve a formulation which would satisfy a given solution technique. The rush to formulate the media selection problem as a linear program is a case in point. There are now hopeful signs that marketing problems will begin to dominate techniques in the formulation of marketing models. This trend has been spurred by maturing experience in the structuring of marketing models, by the realization that successful implementation and use depends upon this approach, and by steady progress in management science and operations research in developing methods for approaching more realistic and complex problems. Although optimization techniques are improving, the trend in marketing is to non-algorithmic techniques such as heuristic programming and simulation. These techniques are more capable of a rich representation of the interdependent and dynamic nature of marketing problems.

Another development is the growing availability of data for estimating and testing models. This should foster the emergence of more realistic, detailed, and valid model structures. The trend toward realistic market response representation is further enhanced by the movement toward the inclusion of more behavioral phenomena, more variables, non-linear response functions, and stochastic elements in marketing models. Dynamic aspects of markets are also increasingly being incorporated into model structures, as in the distributed lag work of Frank and Massy.[16] A significant model trend which is emerging as a result of the development of time shared computers is the trend toward interactive models. An interactive model

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[16] See [18].

operating on a time shared computer system provides a decision maker with the capacity to quickly and efficiently explore the implications of his judgments relative to given problems. The MEDIAC,[17] and ADFORS[18] models provide marketing examples here.

A major development trend is towards inclusion of dynamic and competitive effects. A model which encompasses the dvnamic aspects of markets is the adaptive modeling work of Little.[19] Little has proposed a model for adjusting the advertising budget in the face of a changing environment via a series of continuing market experiments, the results of which are used to update the budget decision.

Another model trend is emerging. This trend is towards building models considering competitive effects[20] and will have a significant interaction with the data bank's functioning. The development of competitive models will need to be supported by data bank capabilities which provide for the systematic monitoring and storing of competitive market data for use in developing, validating, and using these competitive models. Given this trend, it would seem important for firms to consider initiating a program of competitive data generation which will match their future model intentions.

In addition to competitive and dynamic phenomena, there has been a trend towards including more behavioral content in mathematical models. For example, NOMAD has modeled the new product acceptance process basically

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[17] See [16].

[18] See [5].

[19] See [15].

[20] See [6], [10], [11], [35].

as an updating of a brand preference vector on receipt of new advertising awareness, word of mouth communication, and product use experience.[21] This behavioral process approach has been utilized in SPRINTER: mod III at a more aggregated level in an effort to allow many alternatives to be considered.[22] A general development of methods for seeking good solutions to behaviorally based simulation models will play an important role in future models. While better solution methods will be evolved, principle developments will also occur in the methodology of validity and sensitivity testing of complex behaviorally based models.

The trend toward model banks with models which include competitive, dynamic, and behavioral phenomena will increase the importance of models in the total information system.

The Measurement-Statistics Bank

The principal purposes and functions of the measurement-statistics bank are to provide a basis for measurement and estimation and to provide methods for testing response functions as models. In providing a basis for measurement and estimation the measurement-statistics bank should incorporate methods for both data based and judgment based estimation. For example, this bank should include procedures for estimating the demand elasticities of marketing variables based upon data in the data bank. It should also provide methods for making judgmental assessments such as the reference life cycle for a potential new product in an application of a new product model. In testing response functions and models it should

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[21] See [12].

[22] See [38].

provide techniques for assessing the adequacy of a postulated model or function in the light of available data.

In the remainder of this section, measurement methods which should be incorporated and certain aspects of the design of the measurement-statistics bank will be considered.

Methods of Measurement

The methods which should be incorporated into the measurement-statistics bank may be categorized into data based and judgment based methods. Examples of the methods which might be included are given in Figure 2. Although the examples are not exhaustive, they serve to illustrate the nature of the measurement-statistics bank.

Data Based Methods. The first of these are the analysis of variance and other classical parametric procedures which are helpful in analyzing the results of market experiemnts and exploring marketing data for useful relationships. The increasing use of experimental procedures in marketing makes the inclusion of these procedures a necessity. In particular that these methods are key elements in the emergence of adaptive marketing models which make use of continuing market experiments.

Multivariate methods are especially useful in measuring and testing the multiple factor relationships which exist in marketing. Historical data from the data bank will generally serve as input to these procedures. One of the most widely used of these techniques is regression analysis, which finds many uses in estimating and testing market response functions. In view of the need for non-linear response functions in marketing models, the regression capability in the measurement-statistics bank should include methods of non-linear regression.

FIGURE 2

Methods in the Measurement-Statistics Bank

I. Data Based Methods

- A. Analysis of variance and other parametric procedures
- B. Multivariate Procedures
  1. Regression analysis
  2. Discriminant analysis
  3. Factor analysis
  4. Cluster analysis
- C. Non-Parametric Statistics
  1. Cross-classification
  2. Goodness of fit measures
  3. Rank order measures
  4. Non-parametric analysis of variance and multivariate procedures
- D. Time Series Analysis
- E. Numeric Estimation Techniques
- F. Non-Metric Scaling

II. Judgment Based Methods

- A. Decision Theory Program
- B. Methods for Obtaining Judgmental Assessment
- C. Bayesian Multivariate Analysis

Discriminant analysis has found use in such areas as the identification of the characteristics of innovators and early adopters of new products[23] and in assessing the similarity of media audiences.[24] Factor analysis has found use in the identification of latent product attributes[25] and in assessing the dependence of consumer brand and store purchasing behavior upon past behavior.[26] Cluster analysis has been applied to the selection of areas for test marketing.[27] In sum, multivariate methods are increasingly becoming useful tools for marketing management and thereby constitute an important component of the measurement-statistics bank in a marketing information system.

A non-parametric statistics subsystem is useful since it applies to data which do not satisfy the measurement assumptions of the parametric techniques. Cross-classification procedures are especially useful for exploring relationships between sets of classificatory variables and a response measure. Tests to determine the "goodness of fit" are important in the statistical bank in order to determine the descriptive adequacy of models and standard distributions in the face of data. Rank order measures of association are relevant to similar tests where the data are measured on an ordinal scale. Similarly, non-parametric analysis of variance and multivariate procedures are needed when the available data do not satisfy the interval scale assumptions required for the application of the parametric procedures and multivariate analysis discussed above.

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[23] See [30].

[24] See [17].

[25] See [19].

[26] See [29].

[27] See [9] and [25].

Finally, procedures for time series analysis, numeric estimation, and psychrometric scalling are needed. The first is useful in analyzing the dynamics of market response or simulation output. For example, spectral analysis should be a component of the time series subsystem.[28] The second set, numeric estimation techniques, is included to provide the manager with the ability to estimate models whose estimating equations contain complex functions of the model's parameters.[29] It is especially important that a marketing measurement-statistics bank includes this capability in view of the fact that many realistic marketing models prove to be intractible in terms of analytical methods of estimation. It should be noted that these methods will be closely associated with the capacity for non-linear regression. Finally, psychometric procedures are needed. Recent work suggests that these techniques will be increasingly important in the analysis of product and brand competition, in the design of new products, and in the development of market communications such as advertising copy.[30]

Judgment Based Methods. Marketing models, particularly normative models for planning marketing strategy, often require a certain amount of judgmental input. While much remains to be learned about how to obtain judgmental information effectively, it is important that these methods be incorporated into the system as they evolve.

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[28] See [14].

[29] For example, see [23] and [35].

[30] See [8] and [35].

One obvious example of a judgment based method which has applicability in marketing is statistical decision theory.[31] One of the barriers to its use, however, is the computational burden involved in problems large enough to be meaningful. A program which will perform the numerical analysis, preferably in real time from a remote console, should increase the use of this procedure. If a convenient mode of use is made available to marketing managers, it would seem safe to predict an increasingly widespread use of decision theory in marketing. Some simple steps have been made in this direction.[32]

The importance and utility of judgmental inputs and of systems for their evaluation can be illustrated by examples. The first of these, which must remain anonymous for competitive reasons, relates to an application in a company which we shall call Chain Store. Chain Store's problem was to determine which items to feature at what prices in their weekly ads so as to increase store traffic, sales, and profits. A further problem related to how much ad space to allocate to each of the featured items. In conjunction with store managers, a consultant developed a simple model describing how the market would respond to this form of promotion. The model was then made operative on a time shared computer and made available to managers for planning their weekly promotional strategy. The model required judgmental inputs from managers and has been found to produce excellent results in use. The consultant attributes this success to the ability of the managers to provide meaningful judgmental inputs to this

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[31] For example, see [7].

[32] See [34].

simple marketing model. This case would seem to reinforce the notion that useful judgmental inputs to formal analysis can be obtained from marketing managers.

Another example of the use of judgmental inputs is represented by an application of the SPRINTER: mod 0 model to a new chemical product.[33] In this case it was found that managers could give good subjective estimates of market response components, but that without a model they could not combine them effectively to make the GO, ON, or NO decision, and specify a best pricing strategy. Their overall subjective decision was GO for the product, but by combining their component inputs in the model and using their criteria and structure, a NO decision was indicated. Their overall subjective decision was not consistent with the logical combination of their market response judgments. It appears that a model can help produce more consistent decision procedures. In this particular case the subjective market response input and the model were also used to identify a pricing strategy which was predicted to generate 50% more profit.

In view of the importance of subjective inputs, the system should include procedures for monitoring the performance of the judgmental inputs from individuals in the firm. Such procedures will help identify individuals who are particularly knowledgeable as well as provide a basis for adjusting for bias in estimates obtained from an individual. For example, we know of the case of one company in a rapidly growing area which used a combination of judgmental inputs and market data in selecting sites for new outlets.

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[33] See [35].

In this case, monitoring of the performance of individuals supplying judgmental inputs indicated that the operations vice president tended to supply better judgmental inputs than any of the personnel on the real estate staff. When we subsequently resigned, the company not only lost a competent executive but also a valuable source of judgmental marketing information. The system should also seek to correct any systematic bias in the estimates given by each individual. Prof. Henry Claycamp at Stanford has developed such a procedure for a manufacturer of electronic components. The manufacturer asks its salesmen to report on a product-by-product and customer-by-customer basis their subjective probability of realizing a sale in 30 days, 60 days, and 90 days. Each salesman's subjective probabilities are then adjusted on the basis of his past performance in prediction. When aggregated across salesmen, the subjective probability estimates are used as the basis of a short run sales forecast which is used by the production department.

The above examples indicate that judgmental inputs are being used in systematic analysis of marketing problems. Much work remains to be done, however, on the design of techniques for obtaining useful judgmental information. Interesting work has been done by Winkler on the use of experts and group judgments.[34] He has also proposed some interesting notions regarding techniques for providing managers with incentives to supply their best judgments, but more research is needed to develop procedures to generate good subjective estimates.

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[34] See [39], [40] and [32].

Some Design Aspects of the Measurement-Statistics Bank. Computerized statistical analysis has greatly lowered the computational burden in performing such analyses. The proliferation of readily available programs for statistical analysis carries with it a concomitant danger of misuse.[35] It is important that our proposed measurement-statistics bank be designed so as to minimize this danger.

As an example, consider regression analysis. The measurement-statistics bank should incorporate complete econometric capability in terms of all the available tests of the assumptions which underlie the model. This is the first step in lessening the danger of misuse. A second step would be to have the measurement-statistics bank itself warn the user of potential pitfalls and recommend appropriate tests and courses of action. Such system warnings and recommendations should help prevent naive use of this method.

Sometimes it will be possible for the system to automatically get the user out of trouble. For example, the on-line statistical package called DATANAL automatically performs a Fisher exact test when the user has specified a chi-square contingency analysis with insufficient data.[36]

The design of the measurement-statistical bank is especially important since model outputs are only as good as their input. Therefore a good measurement capability is necessary for effective operation of a decision-information operation.

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[35] See [26].

[36] See [21].

The User-System Interface

The last major component of the information system is the subsystem which provides the user-system interface. This interface or system input/output capability is the only direct contact between the user and the system. Consequently, it is crucial that this interface be designed to provide for convenient, efficient user-system interaction if the marketing information system is to have a useful management impact.

While the more traditional batch processing mode of operations will continue to play a useful and important role in marketing information systems of the future, our attention will focus upon the newer capacity for a closely-coupled relationship between manager or user and the system which has been made feasible by the advent of time shared computers.

Time shared systems allow many users to access and use a computer simultaneously. At present the most common form of interactive communication is the remote typewriter. While this form of input/output has been enormously useful and will continue to be so, computer graphics will come to play a much larger role in the future than they now play in marketing information systems. The reason is that graphical display is often a more convenient vehicle with which to communicate with management.

Morton has described the use of such a graphical "management terminal system" in coordinating the planning of marketing and production in the consumer appliance division of Westinghouse.[37] Prior to the

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[37] See [27] and [28].

installation of the graphical system, this process absorbed three weeks of calendar time and about six days of executive time. The graphical system which was installed made use of the same data, models, and analytic approaches which had been in use. Hence the system added nothing more nor less than the capacity for interactive graphical display of such items as forecasted and observed sales, production, and inventory over several time periods by product. The graphical system was found to change the decision making style drastically. The three top level managers who were changed with coordinating marketing and production would now do so by having a session at the interactive vidio console. The calendar time required to plan was reduced from three weeks to one half day and the executive time commitment dropped from six man-days to one. Thus the interactive graphical capability released valuable executive time and furthermore made the organization more responsive to planning errors since the time required to correct a plan was dramatically reduced. In addition to these objective results, it was also felt that decision making had improved as a result of the use of this system.

An example of the communication gains from graphic input in the area of sales management will make the potentials of such an input/output system more evident. Consider the problem of sales territory definition for a large sales force. A map of the area which is to be partitioned into sales territories could be projected on a graphical display device. The graphical device would be connected to a computer which would contain the relevant information about the area and the salesman. For example, the computer might have information regarding the distribution of present and potential customers in the area. The sales manager would then be

provided with a light pen which he could use to partition the graphic display of the area into sales territories. Once he had arrived at a territory definition which he would like to consider, he would then call upon the computer to take the graphic input and evaluate the sales and marketing implications of the proposed territorial definitions. The evaluation would be performed by a sales model or models which would utilize the area information which had been stored in the data bank. If the manager approves of the implications of his current territorial definition, he might decide to adopt the current definition of territories. Probably he would like to explore several alternatives in an effort to achieve a satisfactory (even if not globally optimal) definition. This method of user-machine interaction should enable the manager to utilize effectively his business judgment in creating alternatives. The computer, as an enthusiastic clerk would then assist him in evaluating each alternative. Prototypes of this type of graphical territory definition have been developed at MIT's Project MAC in relation to the political redistricting of Massachusetts.

Interactive systems offer several significant advantages in marketing information systems. While these advantages have not yet been fully demonstrated in formal, scientific studies, experience with such systems to date would tend to reinforce these a priori notions. Interactive systems offer the advantages of better data retrieval and interpretation, more timely answers to questions, and, hopefully, better solutions to problems.

Interactive systems allow effective data retrieval since data requests can be answered almost immediately and a conversational mode

can lead to a succession of questions and answers meaningful to managers. For example, DATANAL allows a user to access a data base, abstract portions of it, manipulate this working data base to answer questions, and carry out statistical analyses.[38] A brand manager could access test market data to find out how many people are aware of his product, then table awareness against preference, and finally use a chi square for significance testing. The ability to browse in the data base, ask questions, and receive answers, greatly enhances the managers ability to interpret data and find problems. A specific marketing example is provided by MARKINF. A language designed to retrieve, manipulate and statistically analyze sales area data.[39]

Interactive systems provide more or less instant access to data, models, and measurement capabilities and thereby provide an important calendar time advantage over batch processing systems. This calendar time advantage has two major payoffs: (1) it may make analysis feasible or enable it to be more thorough, and (2) considerable executive time may be saved. With respect to the first point, an interactive system may make analysis feasible in certain situations which are subject to severe time constraints. Similarly, they may permit more thorough analysis in such situations. In addition to the Westinghouse example above, consider the corporate acquisition process. Standard practice is for the potential acquiring company to have its acquisition officer study the acquisition candidate and develop a set of alternative analyses indicating the future

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[38] See [21].

[39] See [20].

of the parent company, the candidate, and the combined companies. Inevitably, during the negotiating sessions, an officer of one of the companies involved will object to some assumption and will want to substitute an alternative. This can easily result in costly delays as well as necessitate future meetings before an agreement can be reached. An interactive system to produce the desired analysis should reduce these problems. Such a system has been developed by Seaman[40] and is in the process of further development and implementation at Raytheon.

In addition to a real time advantage interactive systems, particularly interactive models, have some differential advantage in solving problems. When a manager can access a model in an interactive mode and try varying input or environmental conditions on the model to see how it reacts, he quickly gains some feeling for how the model responds and whether or not he feels that its behavior is reasonable. Once he has assured himself that it behaves reasonably, the path to management utilization of the model is much smoother. A case in point here would be Little and Lodish's MEDIAC media selection system.[41] This model operates in an interactive mode via a remote teletype. When a media planner is first exposed to this model, he generally trys a variety of alternatives to see if the recommended media schedule makes sense. When he learns that it does, his willingness to utilize the model is considerably enhanced.

It can be concluded that the manager-system interface is a critical component in the decision-information since its effectiveness in a large

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[40] See [31].

[41] See [16].

measure will determine the level of usage of the system. While computer software will improve, a human buffer in the form of a trained specialist probably will still be needed. This specialist would assure that the manager is accessing appropriate models and answer the input and model questions the manager will generate.

Conclusion

This paper has discussed the emerging system concepts in the data bank, model bank, measurement-statistics bank, and manager-interface capability required in a marketing decision-information system. The interdependency between information system components should be re-emphasized. These interdependencies have a significant bearing upon the evolutionary development of a marketing information system and upon the personnel required to achieve a balanced development in the system components. Most existing information systems have been treated as systems for the storage, retrieval, and display of data. This emphasis in not surprising since the team which generally develops such systems is largely composed of computer systems personnel and rarely includes a member of the staff responsible for model based market analysis. As a consequence, most marketing information systems have not achieved a balanced growth or tapped their full potential.

A balanced growth of the system components is necessary if full advantage is to be taken of the new information technology and advances in marketing models and measurements. For example, the data bank design decisions related to the level of data detail and the length of time historical data will be retained place constraints upon the type of marketing models which may be developed at any point in time.

There is also a need for a planned, balanced growth between the model bank and the data support system. For example, one of the features of future marketing model development will be richer representations of competitive interdependencies. Requisite to the development and implementation of such models will be the collection and storage of competitive data, which may involve many months or years for sufficient data to develop. The initial breakthrough will probably be made in data rich industries such as the pharmaceutical industry. It is no accident that the richest market simulation has been developed in the ethical drug market.

In planning the growth and development of a decision information system, the manager is a key element. He sets the system goals, defines problems, and is the raison d'etre of the information system. Often, however, his lack of knowledge about models and their potential has led to an over reliance on the existing data needs and decision structures. This results in systems that function only to retrieve and display data (the data bank functions). In order to assure that the contribution of models, measurement, and statistics are fully realized, management scientists must take an active role in system development. They must make their potential contribution known and they must become deeply involved in the human problems of system development.

If models are to be widely used in the future, they will have to be integrated within the information system context. If the management scientist is involved in the system, his models will probably improve since he will be in a position to help assure that the system will maintain information which will be important in future formulation, estimation,

and validation of marketing models. Without the participation of the management scientist, such information might not be maintained in appropriate form within the system. This improved data will increase the validity of models and, along with the implementation benefits produced by a good system input/output communication facility, will result in greater implementation of management science models.

Three other trends should aid in the design and utilization of decision-information systems. The first is a realization of the basic social-political-psychological issues of system implementation. The second is towards time shared computer utilities. A computer utility offers access to powerful computers and software packages on a usage basis. Thus, what was once an enormous investment in men, machines, and systems has been reduced to much smaller and more convenient units. This lowering of the entry barriers means that the most powerful computers are available to even modest sized firms.

The third and concomitant development has just begun. It is what might be called the "models utility." A model utility is one which makes a model or models available on a syndicated basis via a time shared computer utility. Such a model utility has been formed by Management Decision Systems, Inc. which offers its MEDIAC media planning model, SPRINTER, ADBUG, an advertising budgeting model, and BRANDAID, a brand management model, on a time shared basis. Again, this development has lowered the barriers to smaller organizations. Modest sized firms and agencies may now feasibly have access to the new model technology. It seems safe to predict further developments on this front in the next few years. For example,

model utilities and computer utilities may be combined in a multi-firm marketing information system. In such a system, an independent entity is established for the purchase of computers or computer time, collection of data, and development of data, models, and measurement banks which will be used by all the sponsors. Support of such independent efforts serves to reduce the risks and financial burdens in system development. Such a system is currently being developed by Pharmatech Systems Inc. in the ethical drug market.

The trends toward more effective system utilization and better integration of the decision-information systems, data, models, and measurement banks should lead to more effective system design and more valuable information systems.

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